Space Weather Technical Forecast

Issued on Thursday, 04 May 2023 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1-R2 blackouts expected throughout with a chance of R3 Strong radio blackouts. Very slight chance of G1/Minor Storm conditions on 05 or 06 May. Active electron fluence continuing.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Moderate with a series of M-class flares emanating from AR3293 and AR3296. This series peaked with a M3.9 flare at 04/0843UTC from AR3296. Both AR3293 and AR3296 have both evolved rapidly through the last 24 hours and contain delta spots. AR3297 to the southeast of these regions may also contain a delta region, but is too close to the limb to undertake an adequate analysis. AR3288 in the southeast is still complex and has produced occasional flares as it approaches the limb. In total there are nine sunspot regions on the visible disc, with the remaining five regions all currently relatively simple. A CME leaving the north of coronagraph imagery has been assessed as heading away from the Earth, with no Earth-directed CMEs observed on any available imagery.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 has steadily declined through the last 24 hours, from 500km/s to 400km/s as the high speed stream from coronal hole 98 eases. Density has been below average, Total magnetic field strength was weak. The north-south component of the magnetic field has been weak, but persistently negative since 04/2100UTC. Phi angle was consistently negative (towards the Sun). Geomagnetic activity was Quiet throughout.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, has been at background levels throughout. High energy electron flux (greater than 2MeV) as measured at GOES16, has been at mainly High levels, peaking at 6970pfu at 02/1545UTC, but with brief dips to moderate levels between 04/0300UTC and 04/0700UTC. The 24-hour integrated fluence was at Active levels, with an increasing trend, 3.42e8 integrated pfu recorded at 04/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Moderate to High activity is expected, mainly from the numerous complex regions in the northeast.

Solar Wind / Geomagnetic Activity: No CMEs are expected at Earth within the forecast period. The high speed stream (HSS) from coronal hole 98 is expected to decline, with a connection to the HSS from coronal hole 99 likely on 05 May, followed by a connection to the HSS from coronal hole 01 on 06 May. Speeds are uncertain, but the high speed stream could reach speeds of 400-500km/s. Geomagnetic activity is expected to be mainly Quiet, with a slight chance of Active or G1/Minor Storm intervals on 05 and 06 May.

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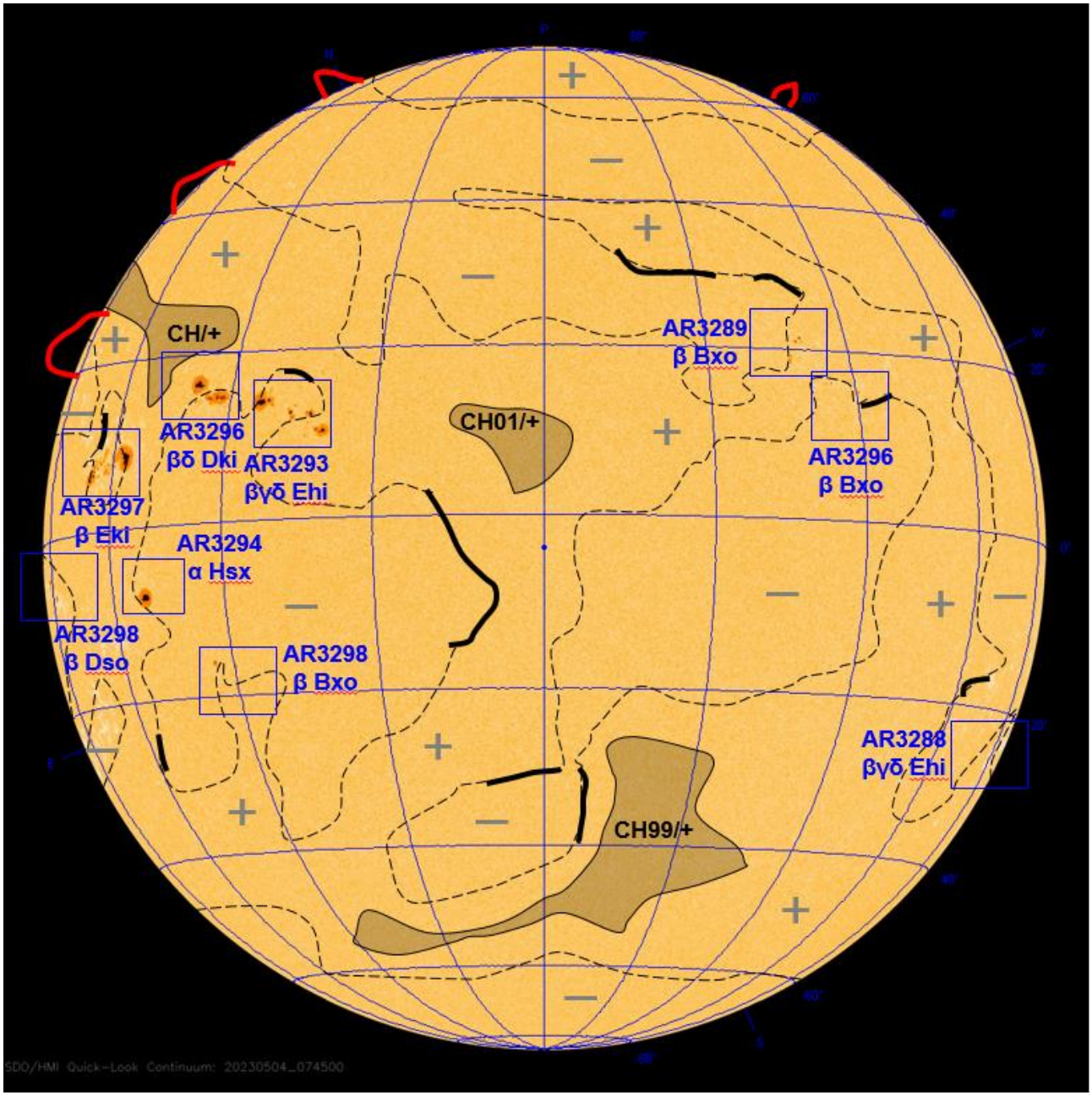
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is most likely to persist at background with no solar radiation storms occurring. High energy (greater than 2MeV) electron flux is expected to continue a diurnal oscillation, mainly above the high threshold, but with slightly declining peaks. Brief sharp declines are possible from low probability geomagnetic activity. Electron fluence is expected to continue above the threshold, with decreasing confidence later in the period.

Figure 1. Solar Analysis Valid 04/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
No Earth-directed CMEs are forecast. A recent eruption seen moving northwards from the solar disc on LASCO C2 and C3 imagery was analysed and determined to be from an eruption on the farside of the Sun.

The current high speed stream from coronal hole 98 is quickly declining as the feature moves across the northwest limb. Coronal hole 99 is then due to connect perhaps later on 05 May, based on STEREO A data which appears to show a broad increase in density. This could be representative of a CIR ahead of the coronal hole. However as this is a non-recurrent feature the possible speed is uncertain. Coronal hole 01 is then due to connect on 06 May. As a semi-recurrent feature the predecessor of coronal hole 01 was evident as a smaller feature on the last rotation, but produced limited observable effects.

Geomagnetic activity is forecast to be mainly Quiet through 04 May, perhaps reaching Active, with a slight chance of G1/Minor Storms on 05 May or 06 due to the anticipated connection to coronal hole 99. Quiet to Unsettled conditions are then likely though to 07 May.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Radio Blackouts - X-Ray Flares:
There are nine sunspot regions on the visible disc, with eight of these numbered. As the complex region AR3288 moves towards the southwest limb it is still producing significant flare activity and remains a risk for both M-class and X-class flare activity. The majority of significant regions are biased towards the eastern hemisphere, with AR3293 showing a moderate level of activity along with AR3296. This region is extremely complex and potentially includes two separate, albeit small delta regions. AR3296 to the east of AR3296 also contains some proto-delta regions and continues to be monitored. Activity has increased in his region, with a M3.9 flare observed early on 04 May. AR3297, close to the eastern limb, may also contain a complex magnetic field structure, but foreshortening is currently inhibiting a thorough analysis. The remaining regions are all relatively simple, but continue to be monitored, especially regions close to the eastern limb, which are currently difficult to analyse.

Solar activity is expected to be mainly Moderate, occasionally high, predominantly due to regions in the northeast of the solar disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 2: GOES-16 X-ray flux

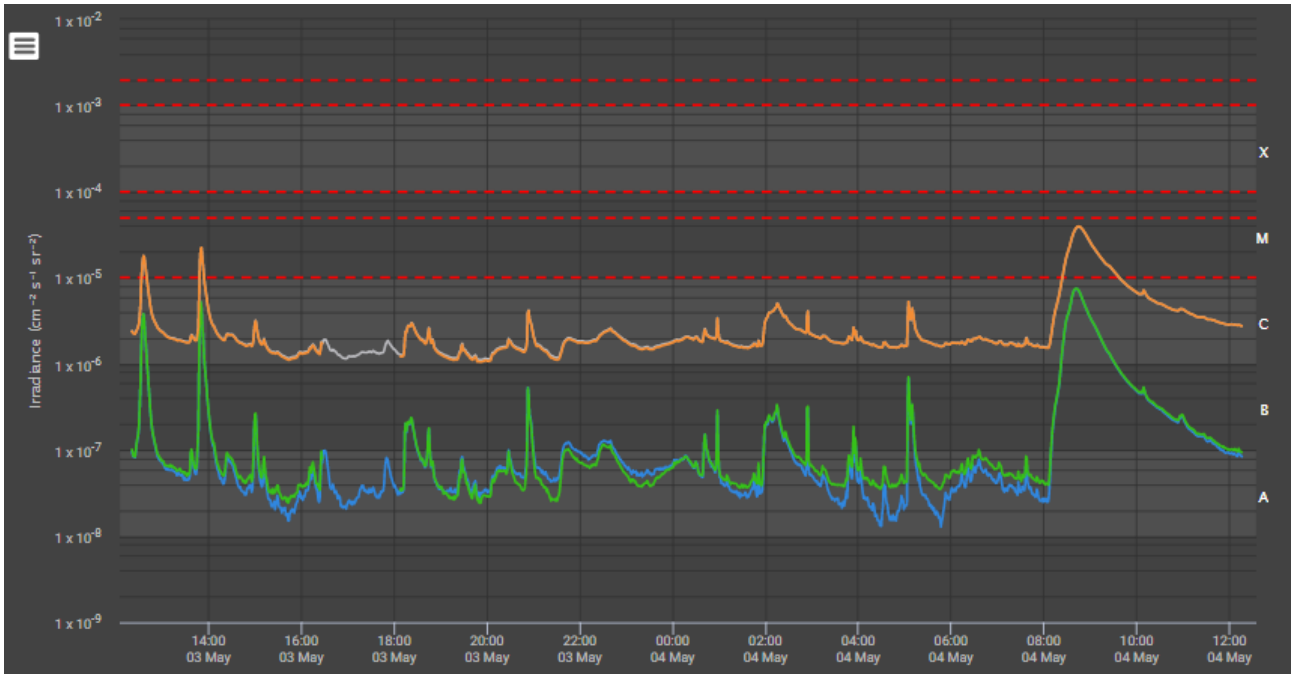

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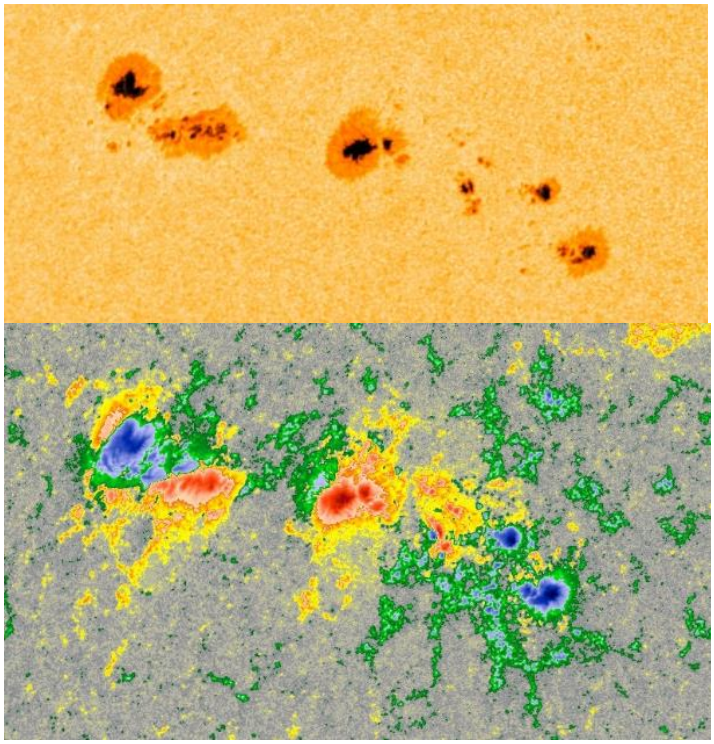
Figure 3: AR3296 (Dki/βδ) (left) and AR3293 (Ehi/βγδ) right in both SDO HMI intensitygram and magnetogram imagery. Delta regions, or developing delta regions, are clearly evident in both groups.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux as observed by GOES-16 is forecast to remain at background levels. However, count rates may increase with any significant flares that occur, mainly from AR3288 in the far southwest with its favourable location for connection with Earth. Therefore there is a very slight chance of reaching the S1 Minor Radiation Storm threshold. Other regions in the east present an increasing, but as yet slight risk of Earth-directed radiation storms.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) levels appear to have been reduced as the Earth begins to leave the high speed stream from coronal hole 98. This is likely to then recover through the next 24 hours, ahead of the connection to the high speed stream from coronal hole 99. As this appears to be preceded by a large CIR. with a high density of particles, there could be sharp decline, due to increased pressure on and distortion of the radiation belts, followed by a sharp increase as the CIR passes and the high speed stream establishes itself. The net effect over the next four days is likely to be mainly high electron flux with variations due to diurnal peaks and troughs.

Electron fluence values are forecast to remain relatively steady, averaging the variations in the electron flux. However this is subject to any significant geomagnetic activity. This is reflected in the reduction of likelihood of exceeding the Active (1e8 integrated pfu) level later in the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	70	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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Figure 4: GOES 16 electron flux and MOSWOC REFM electron fluence

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